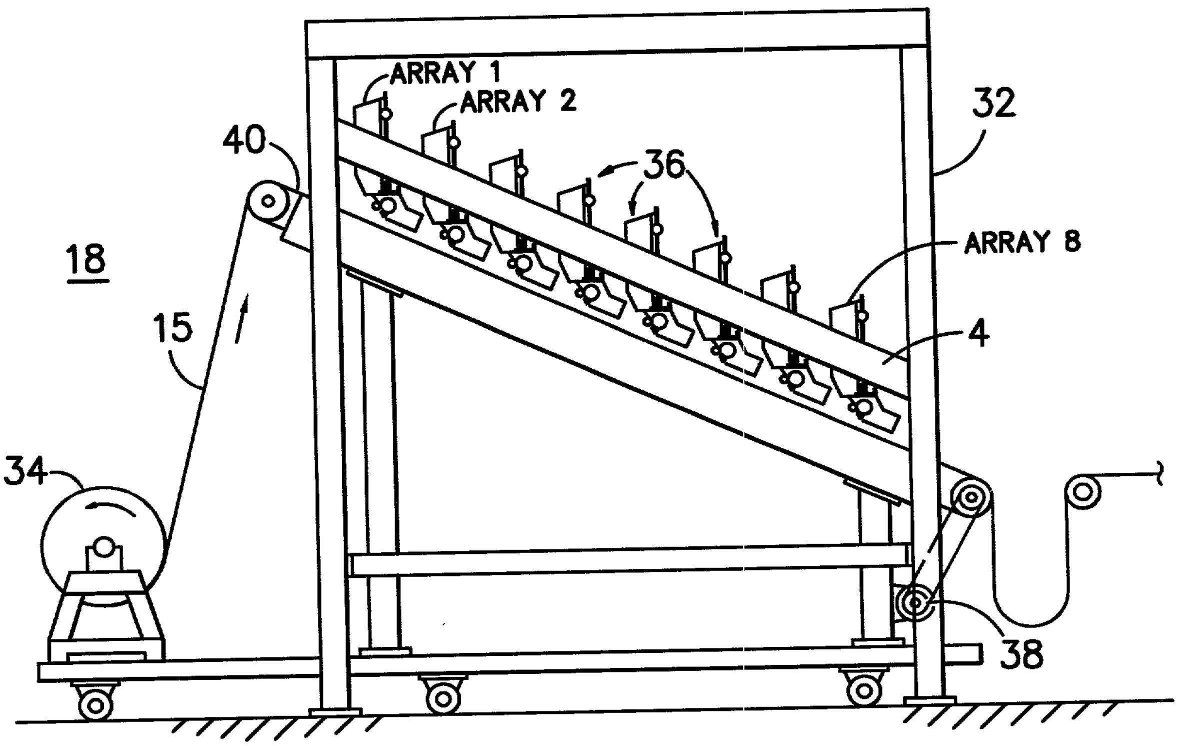


FIG. –1–

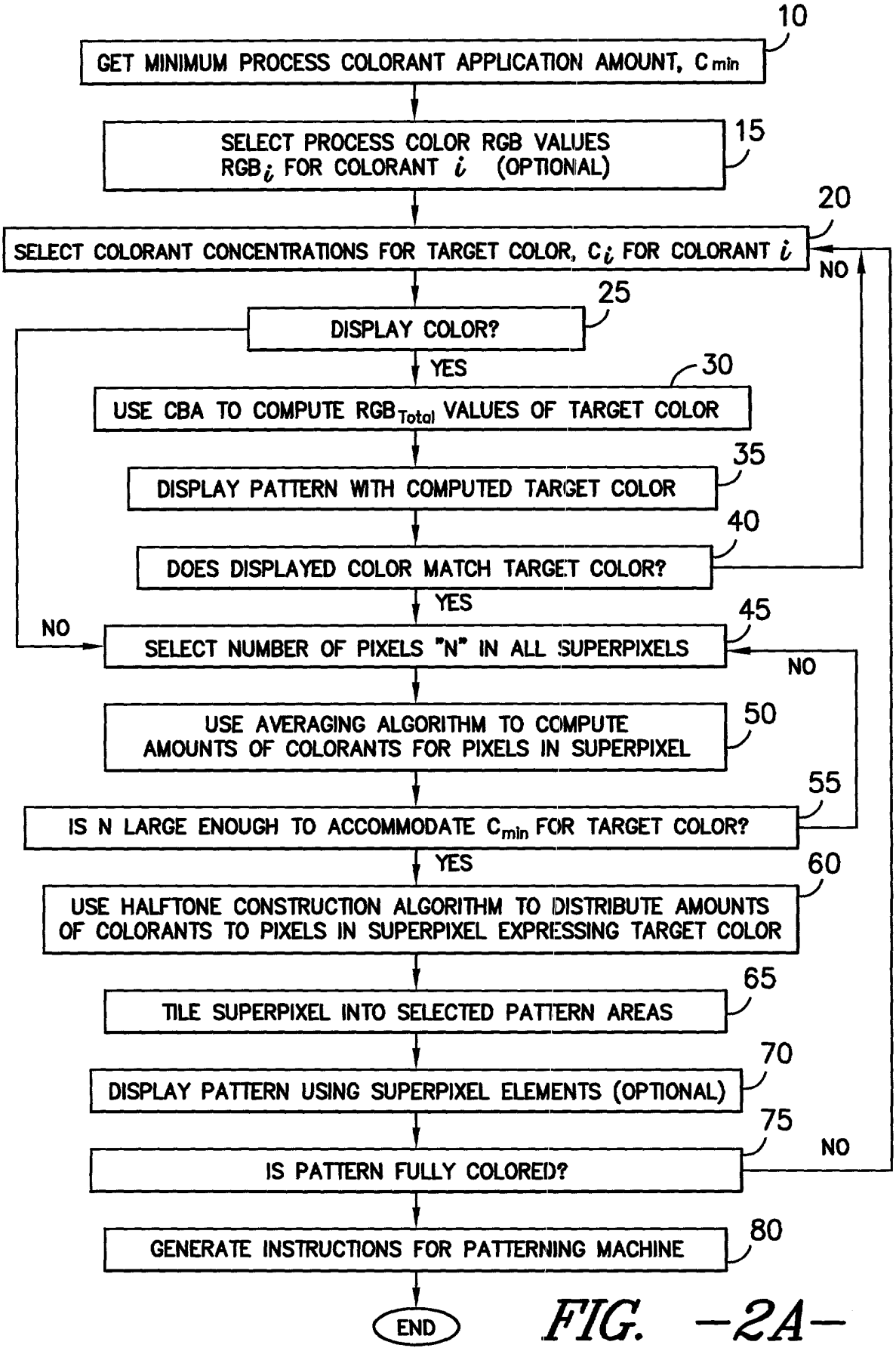


FIG. -2A-

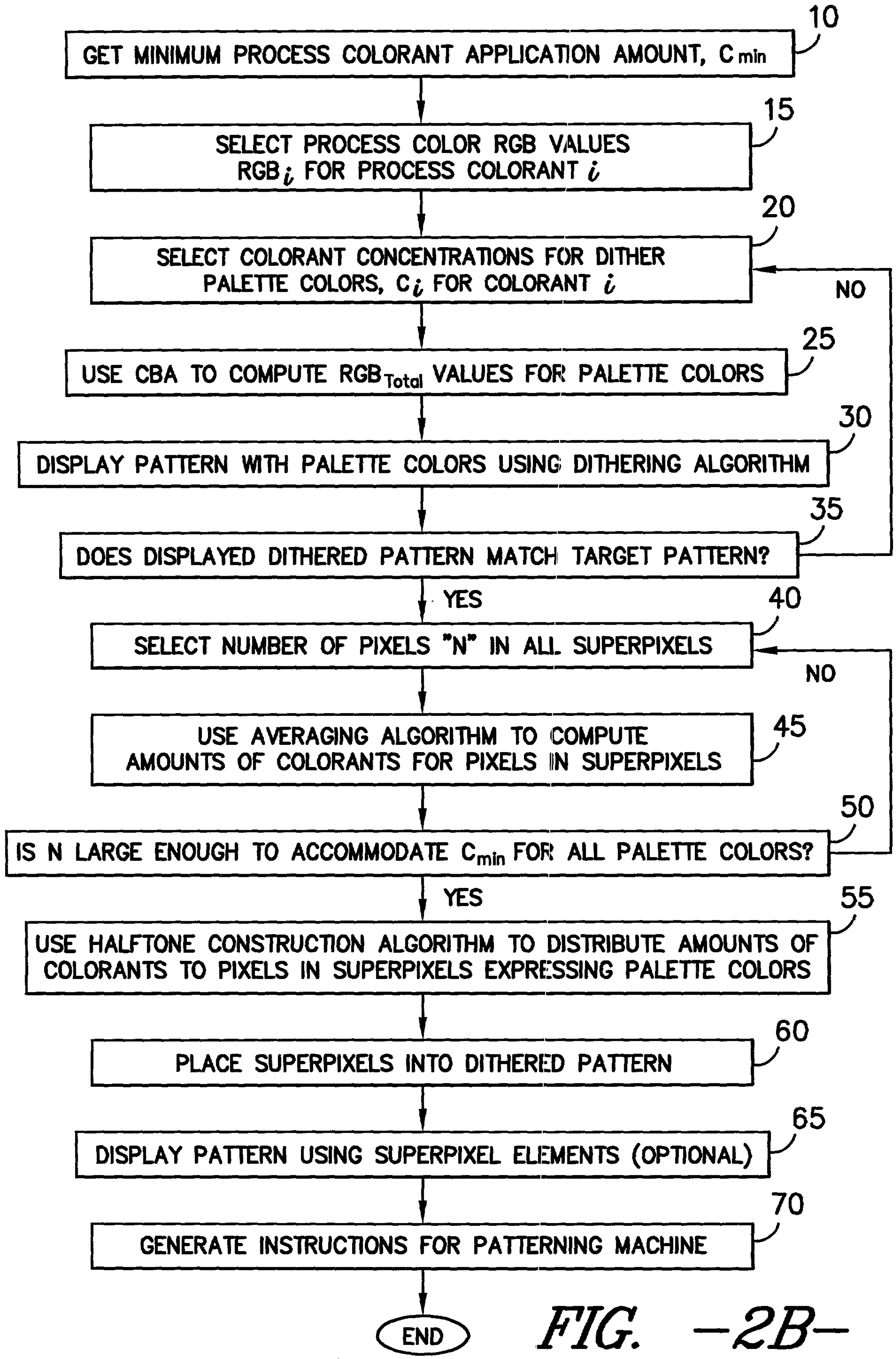


FIG. -2B-

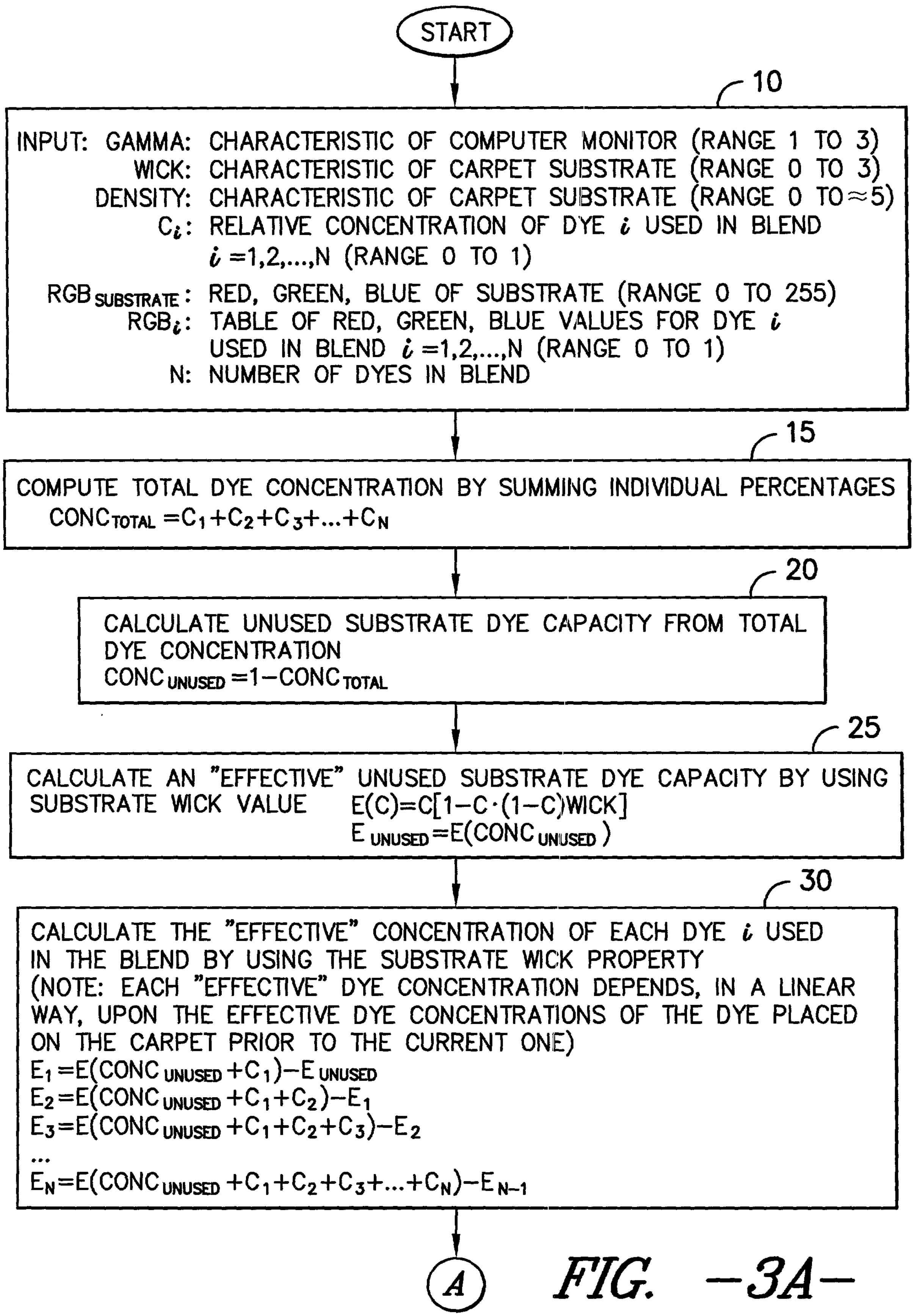

START
10
INPUT: GAMMA: CHARACTERISTIC OF COMPUTER MONITOR (RANGE 1 TO 3)
WICK: CHARACTERISTIC OF CARPET SUBSTRATE (RANGE 0 TO 3)
DENSITY: CHARACTERISTIC OF CARPET SUBSTRATE (RANGE 0 TO ≈5)
C_i: RELATIVE CONCENTRATION OF DYE i USED IN BLEND i =1,2,...,N (RANGE 0 TO 1)
$RGB_{SUBSTRATE}$: RED, GREEN, BLUE OF SUBSTRATE (RANGE 0 TO 255)
RGB_i: TABLE OF RED, GREEN, BLUE VALUES FOR DYE i USED IN BLEND i =1,2,...,N (RANGE 0 TO 1)
N: NUMBER OF DYES IN BLEND
15
COMPUTE TOTAL DYE CONCENTRATION BY SUMMING INDIVIDUAL PERCENTAGES
$CONC_{TOTAL} = C_1 + C_2 + C_3 + \ldots + C_N$
20
CALCULATE UNUSED SUBSTRATE DYE CAPACITY FROM TOTAL DYE CONCENTRATION
$CONC_{UNUSED} = 1 - CONC_{TOTAL}$
25
CALCULATE AN "EFFECTIVE" UNUSED SUBSTRATE DYE CAPACITY BY USING SUBSTRATE WICK VALUE
$E(C) = C[1 - C \cdot (1 - C) WICK]$
$E_{UNUSED} = E(CONC_{UNUSED})$
30
CALCULATE THE "EFFECTIVE" CONCENTRATION OF EACH DYE i USED IN THE BLEND BY USING THE SUBSTRATE WICK PROPERTY
(NOTE: EACH "EFFECTIVE" DYE CONCENTRATION DEPENDS, IN A LINEAR WAY, UPON THE EFFECTIVE DYE CONCENTRATIONS OF THE DYE PLACED ON THE CARPET PRIOR TO THE CURRENT ONE)
$E_1 = E(CONC_{UNUSED} + C_1) - E_{UNUSED}$
$E_2 = E(CONC_{UNUSED} + C_1 + C_2) - E_1$
$E_3 = E(CONC_{UNUSED} + C_1 + C_2 + C_3) - E_2$
...
$E_N = E(CONC_{UNUSED} + C_1 + C_2 + C_3 + \ldots + C_N) - E_{N-1}$
A

FIG. —3A—

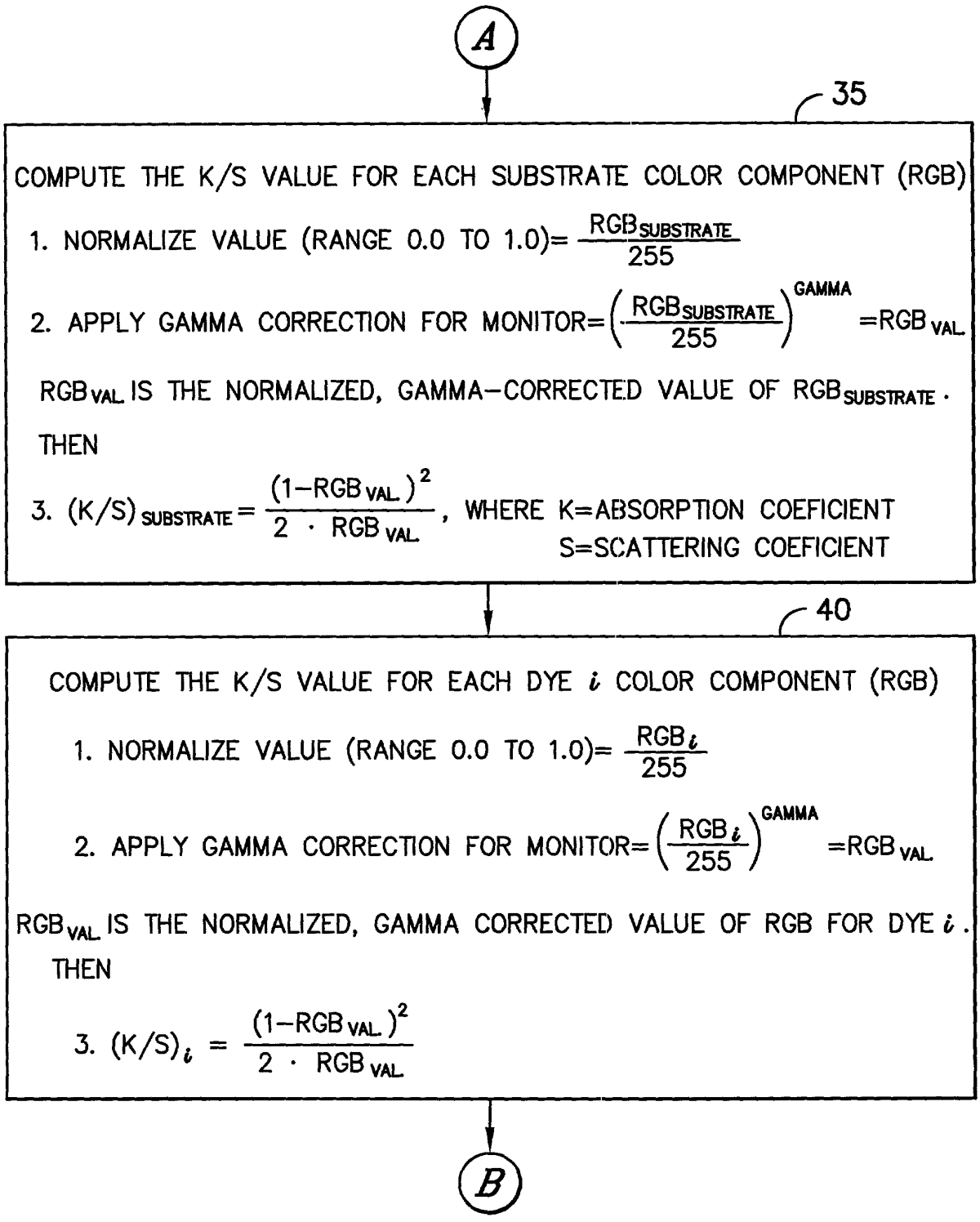

A
35
COMPUTE THE K/S VALUE FOR EACH SUBSTRATE COLOR COMPONENT (RGB)
1. NORMALIZE VALUE (RANGE 0.0 TO 1.0)= RGB SUBSTRATE / 255
2. APPLY GAMMA CORRECTION FOR MONITOR= (RGB SUBSTRATE / 255)^GAMMA =RGB VAL
RGB VAL IS THE NORMALIZED, GAMMA-CORRECTED VALUE OF RGB SUBSTRATE .
THEN
3. (K/S) SUBSTRATE = (1-RGB VAL)^2 / 2 · RGB VAL , WHERE K=ABSORPTION COEFICIENT
S=SCATTERING COEFICIENT
40
COMPUTE THE K/S VALUE FOR EACH DYE i COLOR COMPONENT (RGB)
1. NORMALIZE VALUE (RANGE 0.0 TO 1.0)= RGB i / 255
2. APPLY GAMMA CORRECTION FOR MONITOR= (RGB i / 255)^GAMMA =RGB VAL
RGB VAL IS THE NORMALIZED, GAMMA CORRECTED VALUE OF RGB FOR DYE i .
THEN
3. (K/S) i = (1-RGB VAL)^2 / 2 · RGB VAL
B

FIG. -3B-

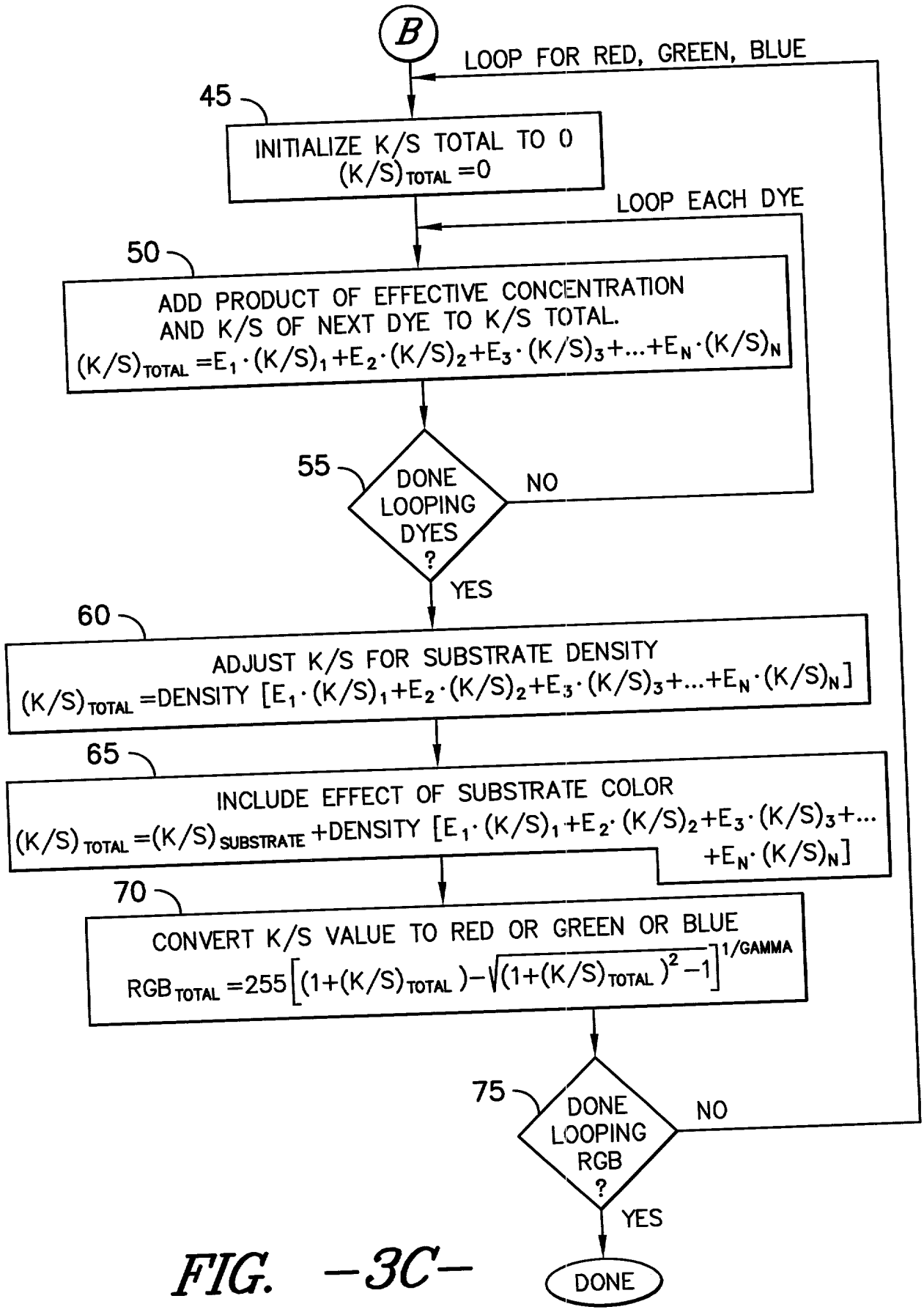

B
LOOP FOR RED, GREEN, BLUE
45
INITIALIZE K/S TOTAL TO 0
$(K/S)_{TOTAL}=0$
LOOP EACH DYE
50
ADD PRODUCT OF EFFECTIVE CONCENTRATION AND K/S OF NEXT DYE TO K/S TOTAL.
$(K/S)_{TOTAL}=E_1\cdot(K/S)_1+E_2\cdot(K/S)_2+E_3\cdot(K/S)_3+\ldots+E_N\cdot(K/S)_N$
55
DONE LOOPING DYES ?
NO
YES
60
ADJUST K/S FOR SUBSTRATE DENSITY
$(K/S)_{TOTAL}=\text{DENSITY}\,[E_1\cdot(K/S)_1+E_2\cdot(K/S)_2+E_3\cdot(K/S)_3+\ldots+E_N\cdot(K/S)_N]$
65
INCLUDE EFFECT OF SUBSTRATE COLOR
$(K/S)_{TOTAL}=(K/S)_{SUBSTRATE}+\text{DENSITY}\,[E_1\cdot(K/S)_1+E_2\cdot(K/S)_2+E_3\cdot(K/S)_3+\ldots+E_N\cdot(K/S)_N]$
70
CONVERT K/S VALUE TO RED OR GREEN OR BLUE
$RGB_{TOTAL}=255\left[(1+(K/S)_{TOTAL})-\sqrt{(1+(K/S)_{TOTAL})^2-1}\right]^{1/GAMMA}$
75
DONE LOOPING RGB ?
NO
YES
DONE

FIG. —3C—

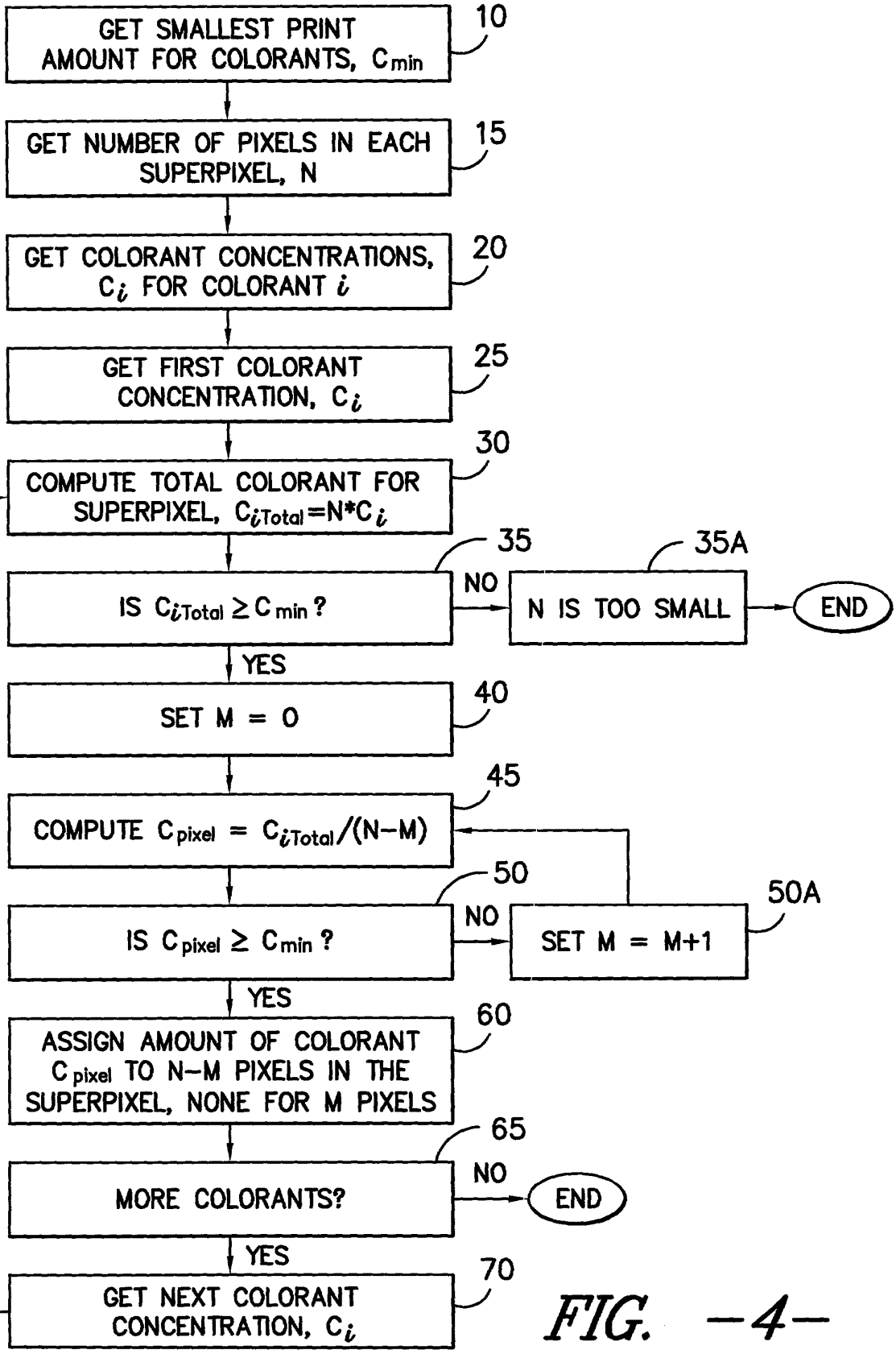

GET SMALLEST PRINT AMOUNT FOR COLORANTS, C_{min}
10
GET NUMBER OF PIXELS IN EACH SUPERPIXEL, N
15
GET COLORANT CONCENTRATIONS, C_i FOR COLORANT i
20
GET FIRST COLORANT CONCENTRATION, C_i
25
COMPUTE TOTAL COLORANT FOR SUPERPIXEL, $C_{iTotal}=N*C_i$
30
IS $C_{iTotal} \geq C_{min}$?
35
NO
N IS TOO SMALL
35A
END
YES
SET M = 0
40
COMPUTE $C_{pixel} = C_{iTotal}/(N-M)$
45
IS $C_{pixel} \geq C_{min}$?
50
NO
SET M = M+1
50A
YES
ASSIGN AMOUNT OF COLORANT C_{pixel} TO N-M PIXELS IN THE SUPERPIXEL, NONE FOR M PIXELS
60
MORE COLORANTS?
65
NO
END
YES
GET NEXT COLORANT CONCENTRATION, C_i
70

FIG. —4—

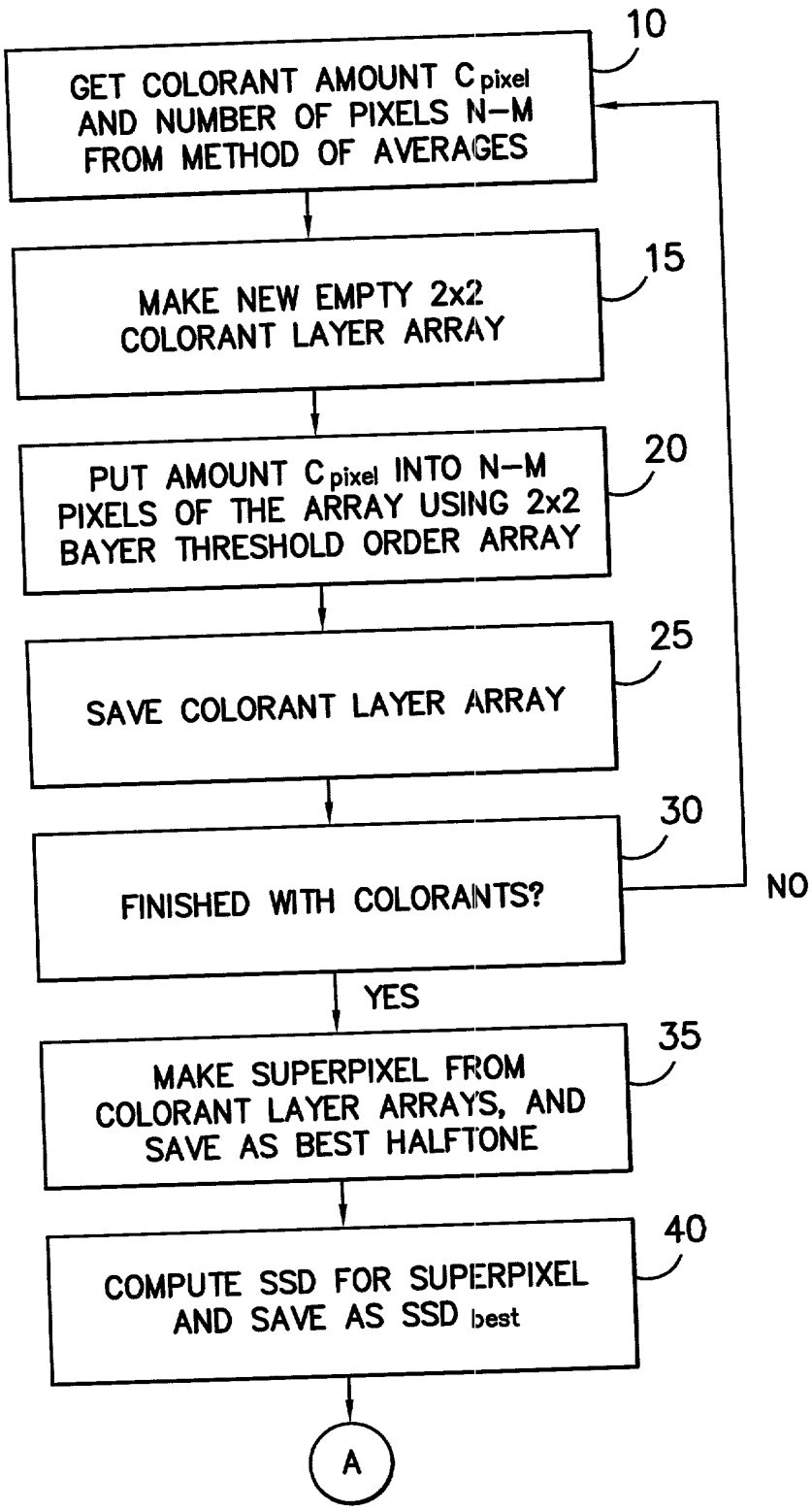

10
GET COLORANT AMOUNT C_{pixel} AND NUMBER OF PIXELS N–M FROM METHOD OF AVERAGES
15
MAKE NEW EMPTY 2x2 COLORANT LAYER ARRAY
20
PUT AMOUNT C_{pixel} INTO N–M PIXELS OF THE ARRAY USING 2x2 BAYER THRESHOLD ORDER ARRAY
25
SAVE COLORANT LAYER ARRAY
30
FINISHED WITH COLORANTS?
NO
YES
35
MAKE SUPERPIXEL FROM COLORANT LAYER ARRAYS, AND SAVE AS BEST HALFTONE
40
COMPUTE SSD FOR SUPERPIXEL AND SAVE AS SSD_{best}
A

FIG. –5A–

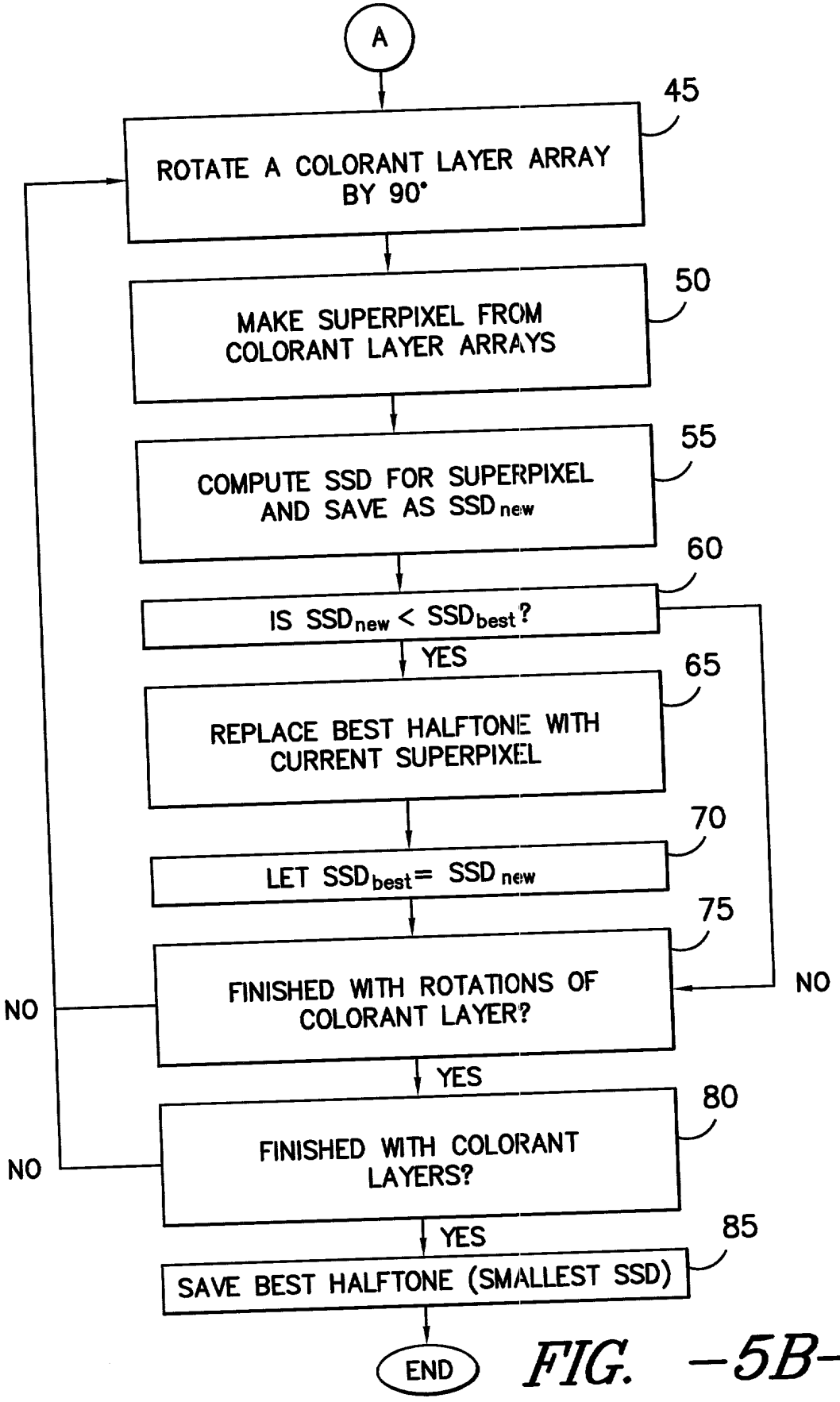

A
45
ROTATE A COLORANT LAYER ARRAY BY 90°
50
MAKE SUPERPIXEL FROM COLORANT LAYER ARRAYS
55
COMPUTE SSD FOR SUPERPIXEL AND SAVE AS SSD new
60
IS SSDnew < SSDbest?
YES
65
REPLACE BEST HALFTONE WITH CURRENT SUPERPIXEL
70
LET SSDbest = SSD new
75
FINISHED WITH ROTATIONS OF COLORANT LAYER?
NO
NO
YES
80
FINISHED WITH COLORANT LAYERS?
NO
YES
85
SAVE BEST HALFTONE (SMALLEST SSD)
END

FIG. -5B-

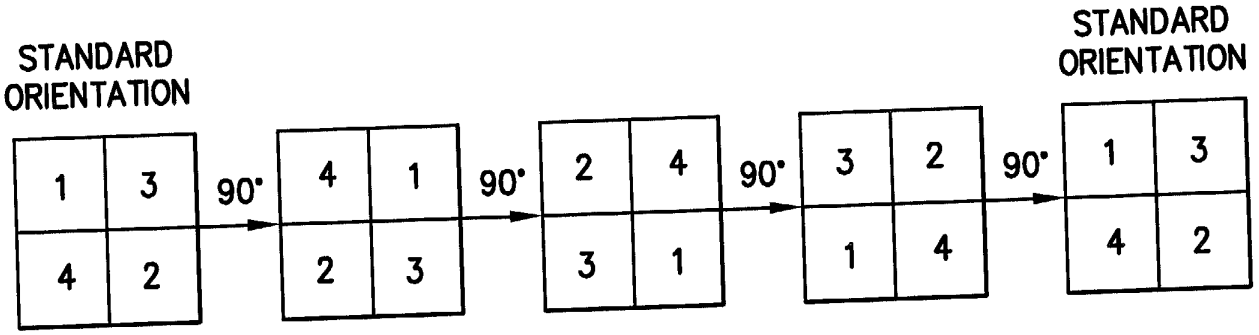


FIG. –6–

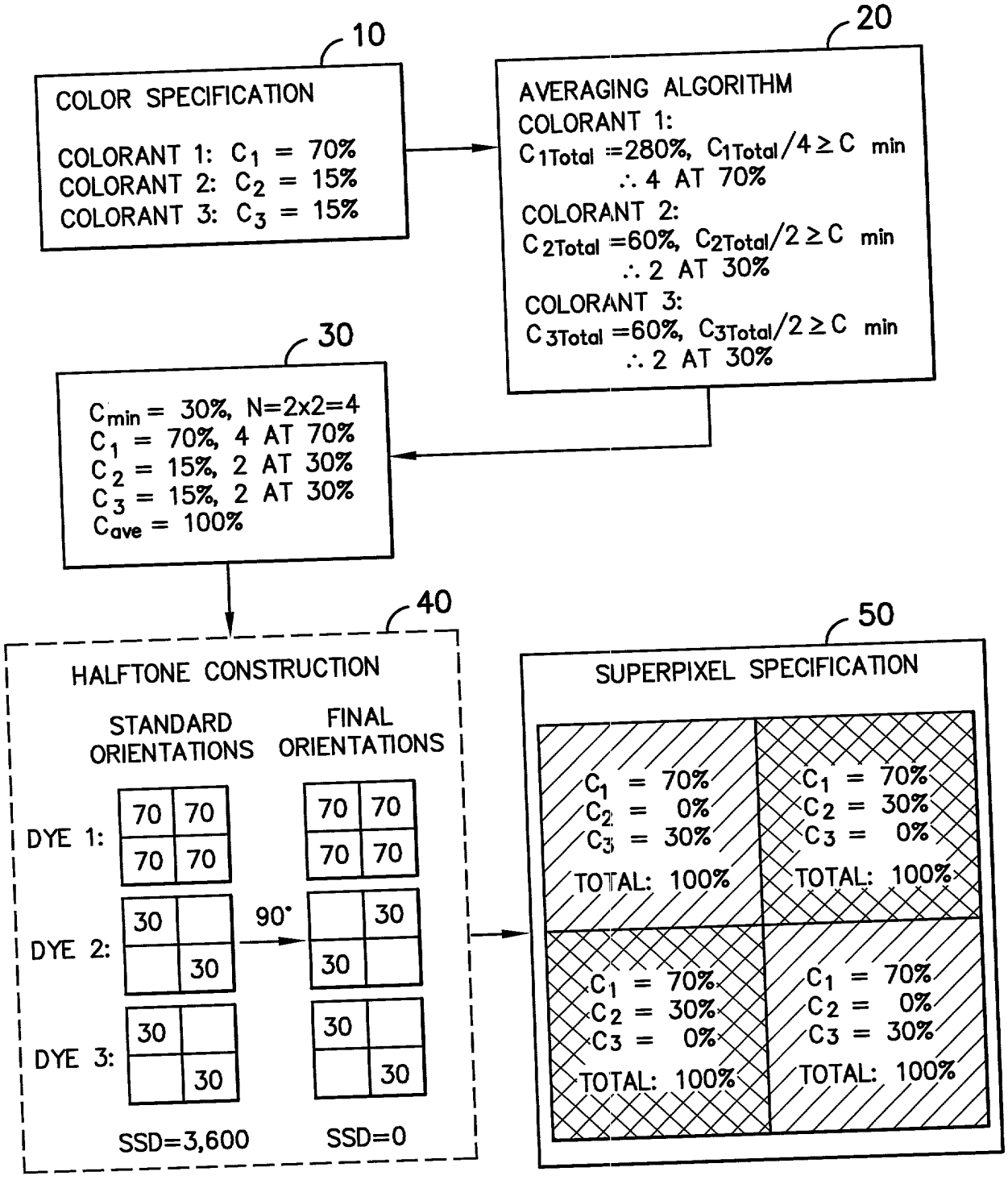

10
COLOR SPECIFICATION
COLORANT 1: C_1 = 70%
COLORANT 2: C_2 = 15%
COLORANT 3: C_3 = 15%
20
AVERAGING ALGORITHM
COLORANT 1:
C_{1Total} =280%, $C_{1Total}/4 \geq C_{min}$
∴ 4 AT 70%
COLORANT 2:
C_{2Total} =60%, $C_{2Total}/2 \geq C_{min}$
∴ 2 AT 30%
COLORANT 3:
C_{3Total} =60%, $C_{3Total}/2 \geq C_{min}$
∴ 2 AT 30%
30
C_{min} = 30%, N=2x2=4
C_1 = 70%, 4 AT 70%
C_2 = 15%, 2 AT 30%
C_3 = 15%, 2 AT 30%
C_{ave} = 100%
40
HALFTONE CONSTRUCTION
STANDARD ORIENTATIONS
FINAL ORIENTATIONS
DYE 1:
DYE 2:
DYE 3:
90°
SSD=3,600
SSD=0
50
SUPERPIXEL SPECIFICATION
C_1 = 70%
C_2 = 0%
C_3 = 30%
TOTAL: 100%
C_1 = 70%
C_2 = 30%
C_3 = 0%
TOTAL: 100%
C_1 = 70%
C_2 = 30%
C_3 = 0%
TOTAL: 100%
C_1 = 70%
C_2 = 0%
C_3 = 30%
TOTAL: 100%

FIG. —7—

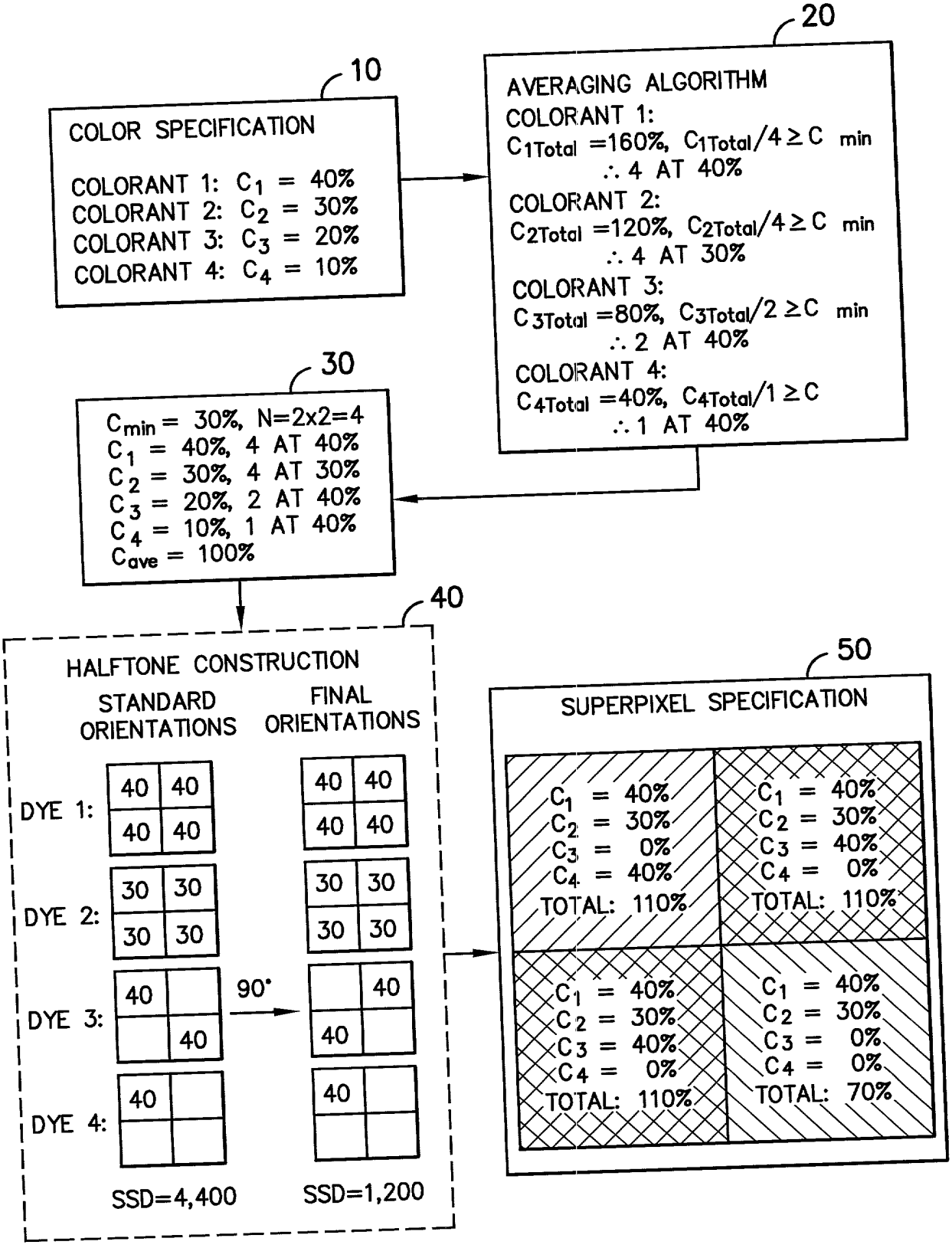

10
COLOR SPECIFICATION
COLORANT 1: C1 = 40%
COLORANT 2: C2 = 30%
COLORANT 3: C3 = 20%
COLORANT 4: C4 = 10%
20
AVERAGING ALGORITHM
COLORANT 1:
C1Total =160%, C1Total/4 ≥ C min
∴ 4 AT 40%
COLORANT 2:
C2Total =120%, C2Total/4 ≥ C min
∴ 4 AT 30%
COLORANT 3:
C3Total =80%, C3Total/2 ≥ C min
∴ 2 AT 40%
COLORANT 4:
C4Total =40%, C4Total/1 ≥ C
∴ 1 AT 40%
30
Cmin = 30%, N=2x2=4
C1 = 40%, 4 AT 40%
C2 = 30%, 4 AT 30%
C3 = 20%, 2 AT 40%
C4 = 10%, 1 AT 40%
Cave = 100%
40
HALFTONE CONSTRUCTION
STANDARD ORIENTATIONS
FINAL ORIENTATIONS
DYE 1:
DYE 2:
DYE 3:
DYE 4:
90°
SSD=4,400
SSD=1,200
50
SUPERPIXEL SPECIFICATION
C1 = 40%
C2 = 30%
C3 = 0%
C4 = 40%
TOTAL: 110%
C1 = 40%
C2 = 30%
C3 = 40%
C4 = 0%
TOTAL: 110%
C1 = 40%
C2 = 30%
C3 = 40%
C4 = 0%
TOTAL: 110%
C1 = 40%
C2 = 30%
C3 = 0%
C4 = 0%
TOTAL: 70%

FIG. —8—

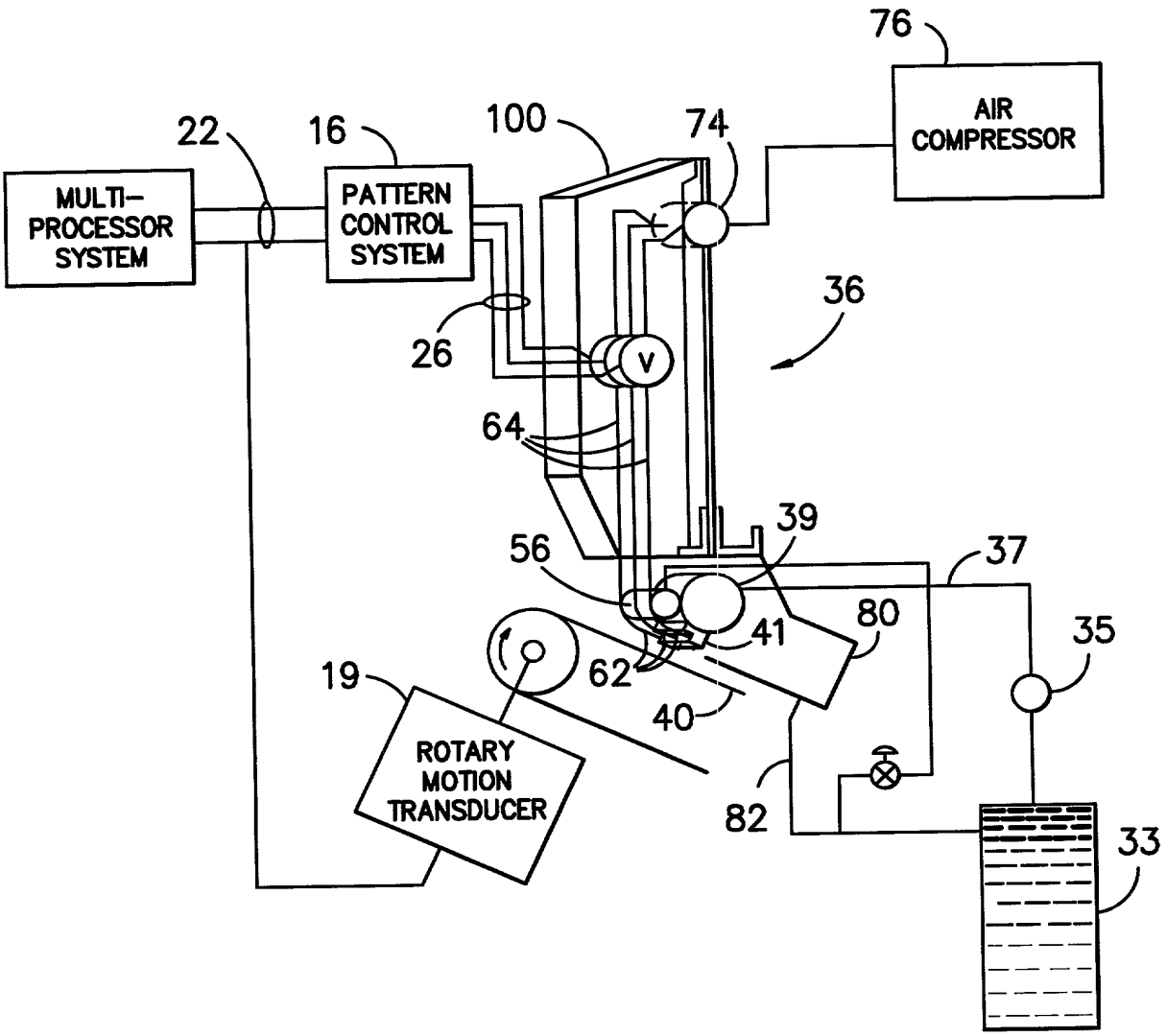
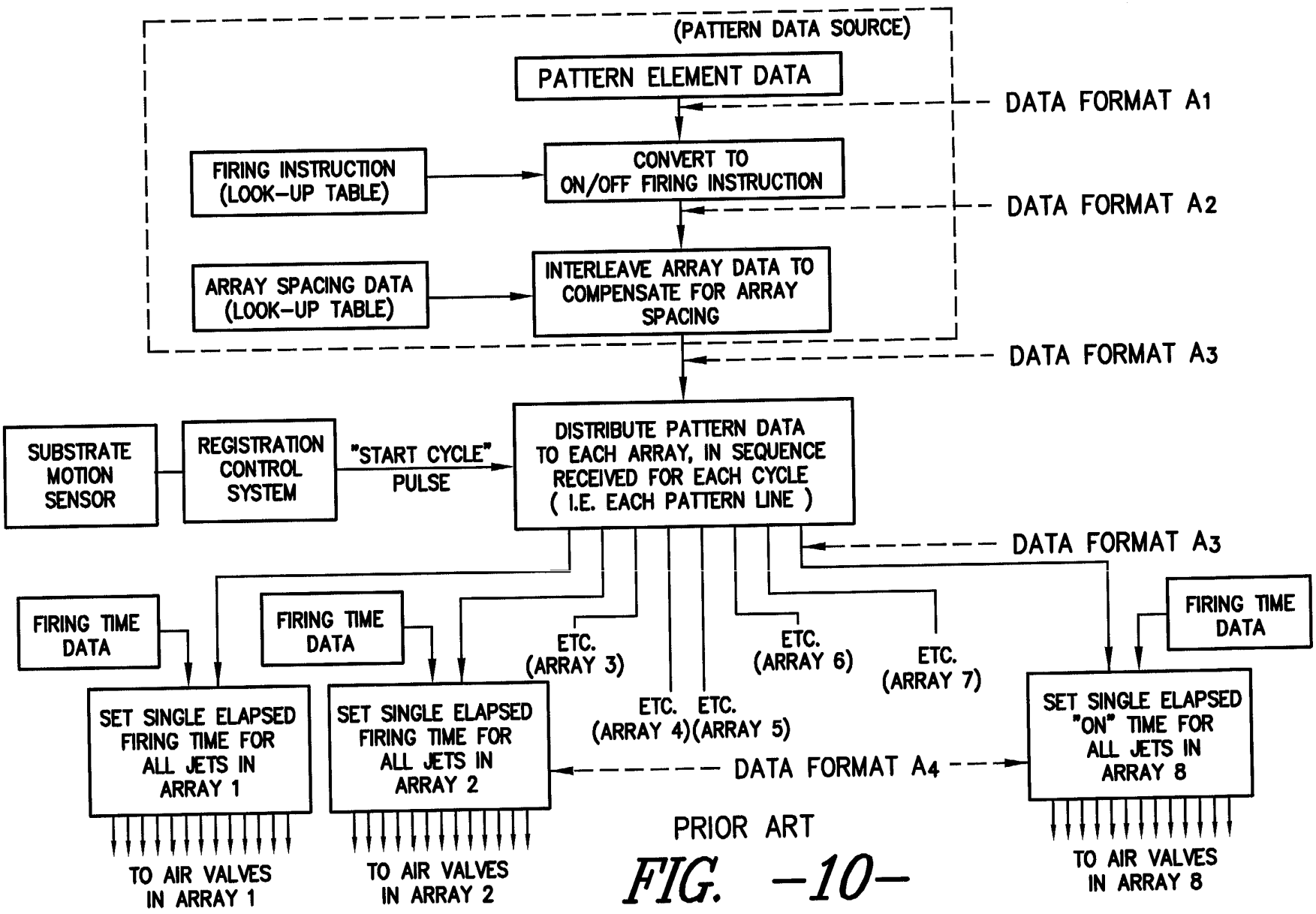

76
AIR COMPRESSOR
22
16
100
74
MULTI-PROCESSOR SYSTEM
PATTERN CONTROL SYSTEM
36
26
V
64
39
56
37
80
41
35
62
19
40
ROTARY MOTION TRANSDUCER
82
33

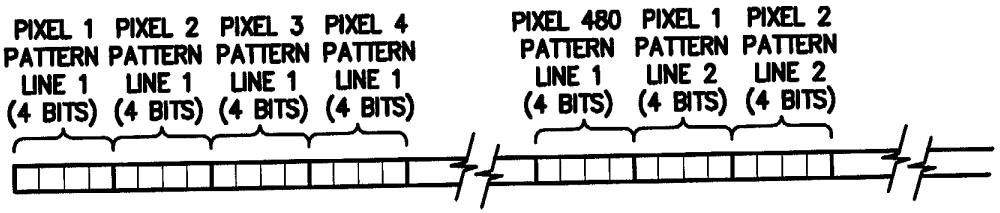
FIG. —9—



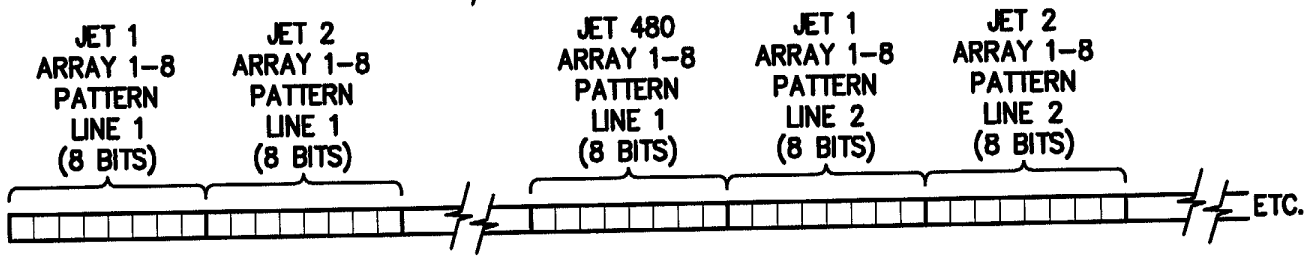
PRIOR ART

FIG. –10–

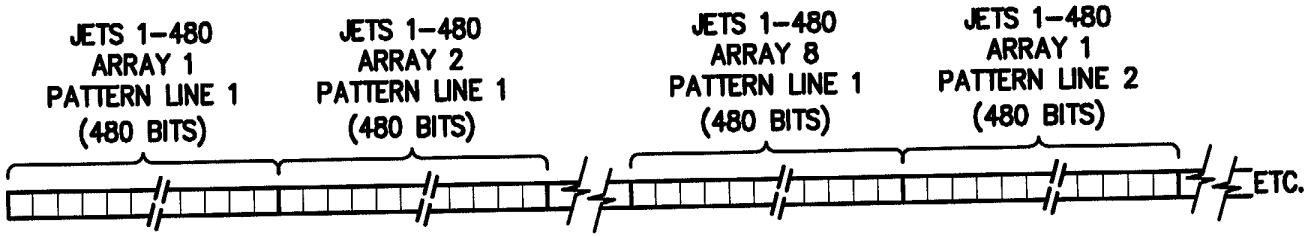
DATA FORMAT A1 :
4 BIT GROUP
DEFINES 1 OF 16 PRE-DEFINED
PATTERN ELEMENTS



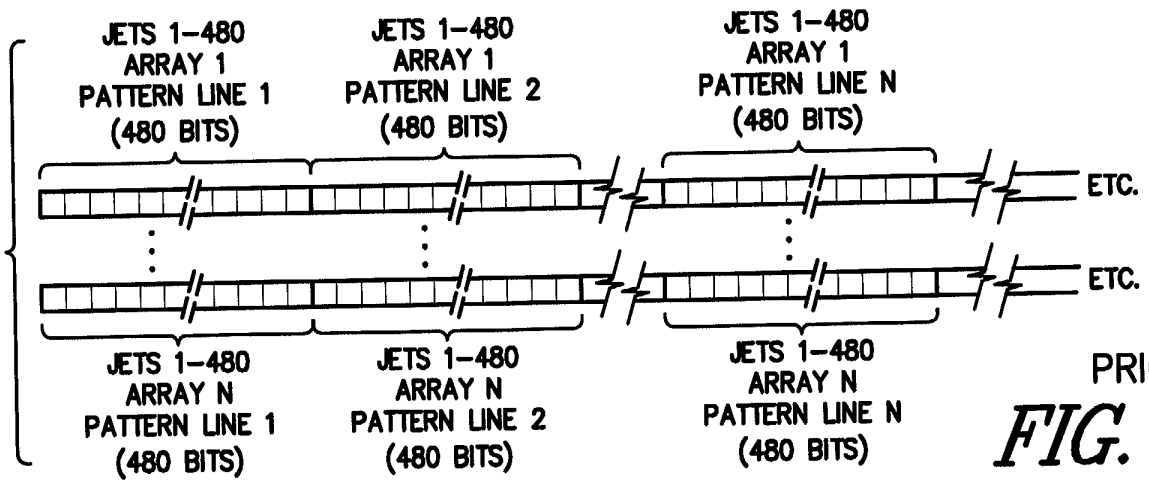
DATA FORMAT A2 :
EACH BIT INDICATES
"FIRE / NO FIRE"
FOR EACH JET ON
EACH ARRAY



DATA FORMAT A3 :
(EACH BIT INDICATES
"FIRE / NO FIRE" FOR EACH JET;
FIRING TIME TO BE PRESET)



DATA FORMAT A4 :
(EACH BIT INDICATES
"FIRE / NO FIRE" FOR EACH JET;
FIRING TIME IS PRESET)



PRIOR ART

FIG. —11—

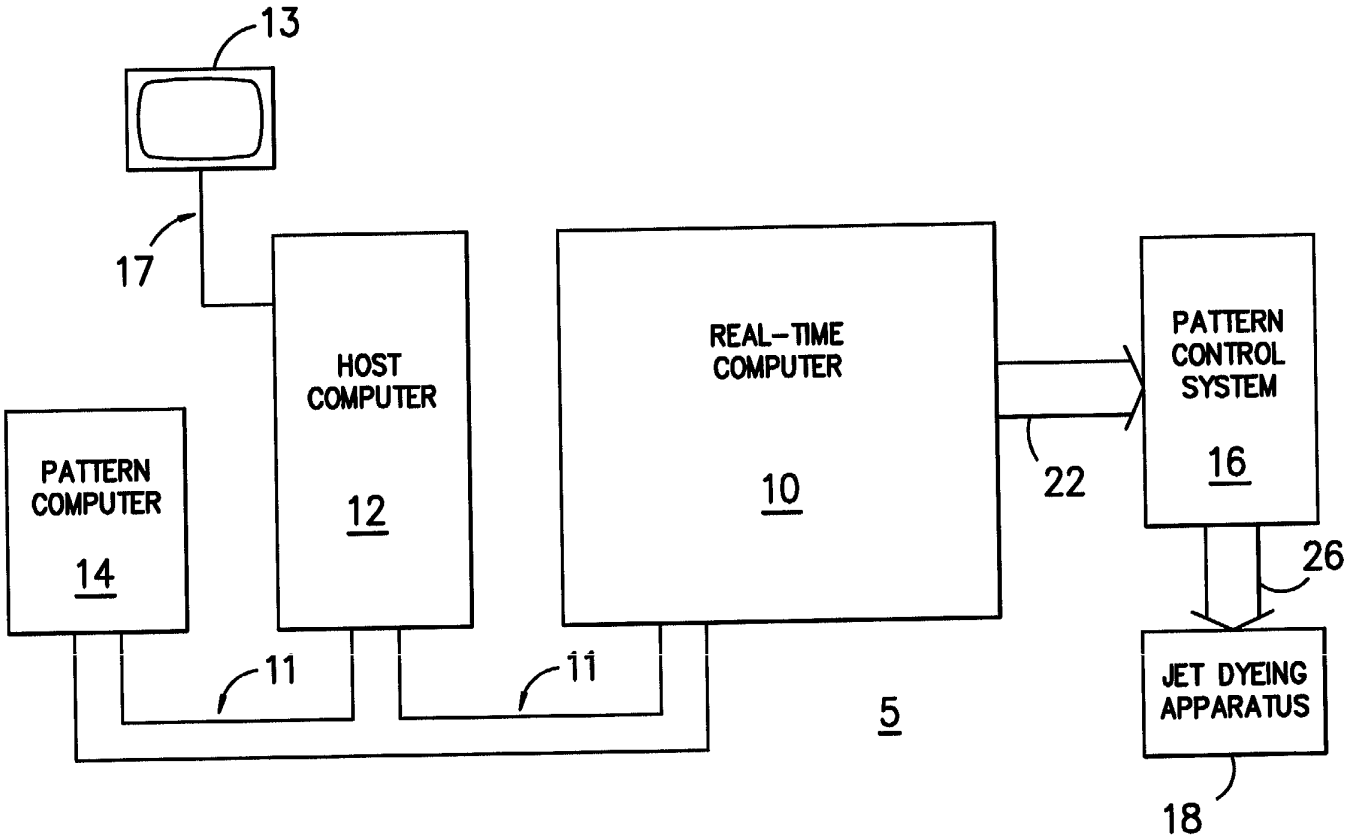


FIG. -12-

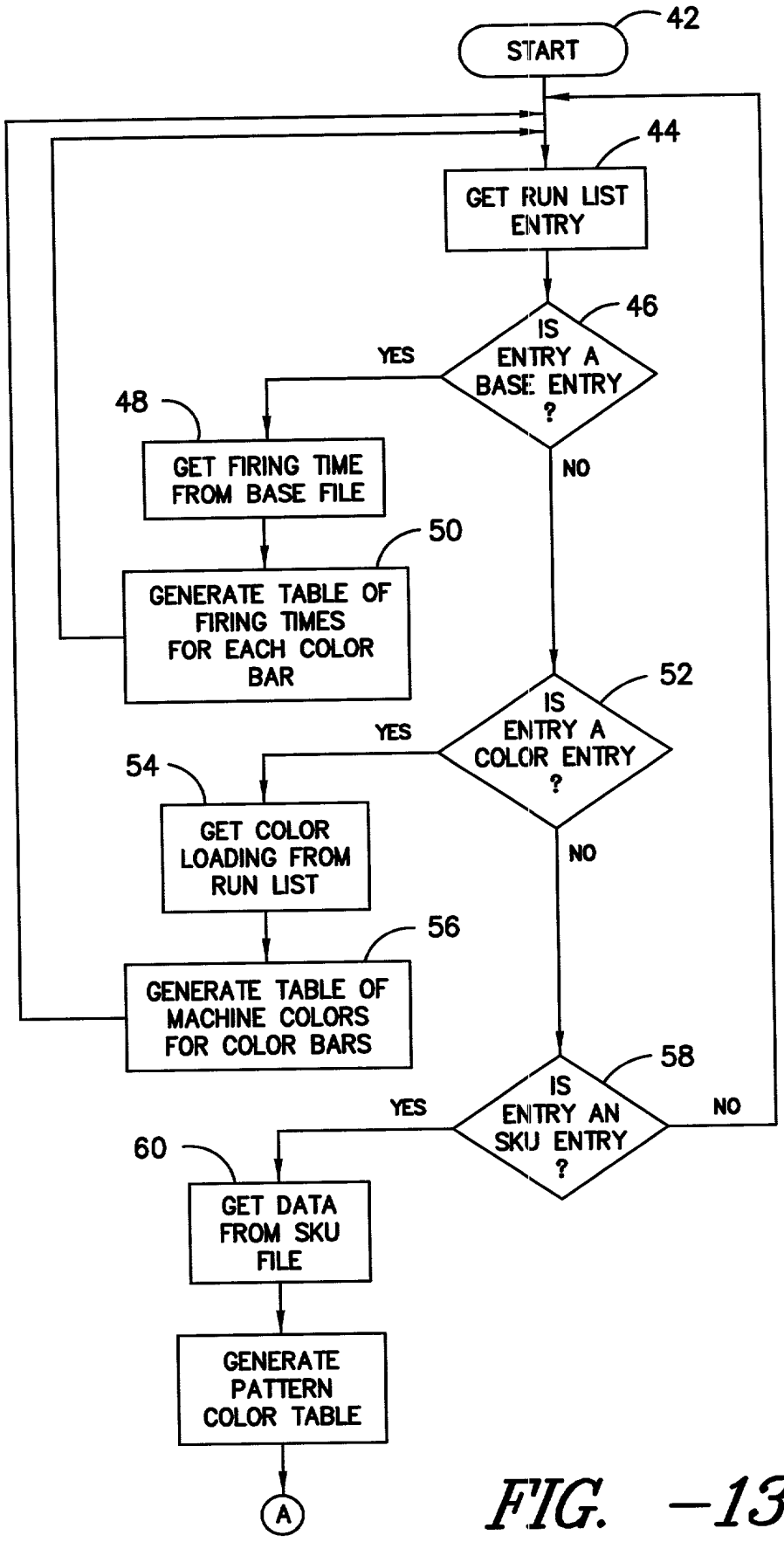

42
START
44
GET RUN LIST ENTRY
46
IS ENTRY A BASE ENTRY ?
YES
NO
48
GET FIRING TIME FROM BASE FILE
50
GENERATE TABLE OF FIRING TIMES FOR EACH COLOR BAR
52
IS ENTRY A COLOR ENTRY ?
YES
NO
54
GET COLOR LOADING FROM RUN LIST
56
GENERATE TABLE OF MACHINE COLORS FOR COLOR BARS
58
IS ENTRY AN SKU ENTRY ?
YES
NO
60
GET DATA FROM SKU FILE
GENERATE PATTERN COLOR TABLE
A

FIG. —13—

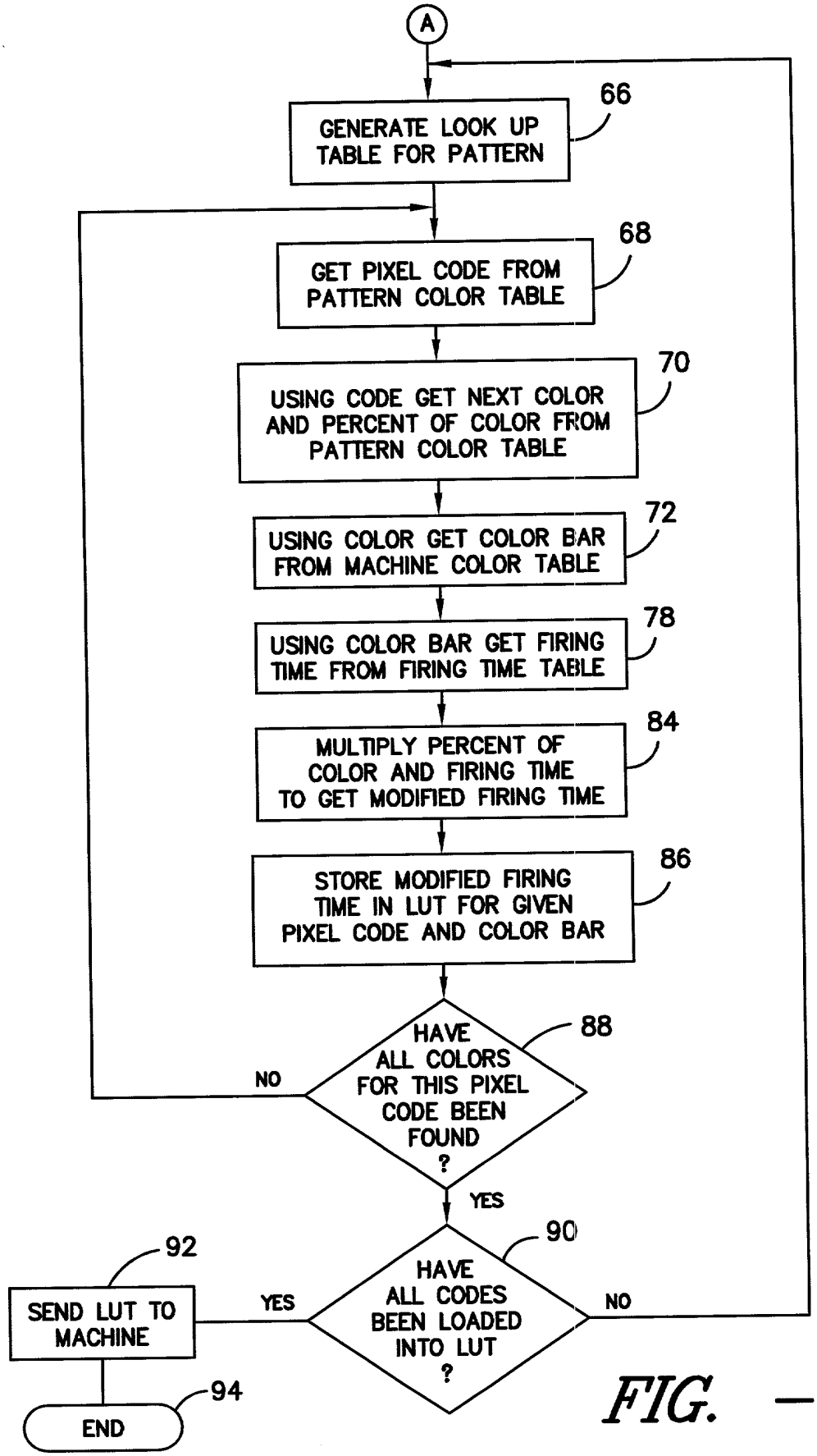

A
GENERATE LOOK UP TABLE FOR PATTERN
66
GET PIXEL CODE FROM PATTERN COLOR TABLE
68
USING CODE GET NEXT COLOR AND PERCENT OF COLOR FROM PATTERN COLOR TABLE
70
USING COLOR GET COLOR BAR FROM MACHINE COLOR TABLE
72
USING COLOR BAR GET FIRING TIME FROM FIRING TIME TABLE
78
MULTIPLY PERCENT OF COLOR AND FIRING TIME TO GET MODIFIED FIRING TIME
84
STORE MODIFIED FIRING TIME IN LUT FOR GIVEN PIXEL CODE AND COLOR BAR
86
HAVE ALL COLORS FOR THIS PIXEL CODE BEEN FOUND ?
88
NO
YES
HAVE ALL CODES BEEN LOADED INTO LUT ?
90
YES
NO
SEND LUT TO MACHINE
92
END
94

FIG. -14-

BASE WXYZ

BAR	FT
1	10
2	10
3	20
4	15

FIG. –15A–

MACHINE CONFIG.

COLOR	BAR
RED	1
BLUE	2
GREEN	3
YELLOW	4

FIG. –15B–

SKU ABC

CODE	COLOR
A	RED
B	BLUE

FIG. –15C–

BASE WXYZ

BAR	FT
1	10
2	10
3	20
4	15

FIG. –16A–

MACHINE CONFIG.

COLOR	BAR
RED	1
BLUE	2
GREEN	3
YELLOW	4

FIG. –16B–

SKU ADE

CODE	COLOR
A	50% RED, 50% BLUE
C	GREEN

FIG. –16C–

LUT'S

CODES	1	2	3	4
A	10MS	0	0	0
B	0	10MS	0	0

FIG. –15D–

LUT'S

	1	2	3	4
A	5MS	5MS	0	0
C	0	0	20MS	0

FIG. –16D–

LUT'S

	1	2	3	4
A	0	0	20MS	0
B	0	10MS	0	0
C	5MS	2.5MS	0	3.75MS

FIG. –16E–

LUT'S

	1	2	3	4	5
A	0	0	0	0	10MS
B	0	10MS	0	0	0

FIG. –16F–

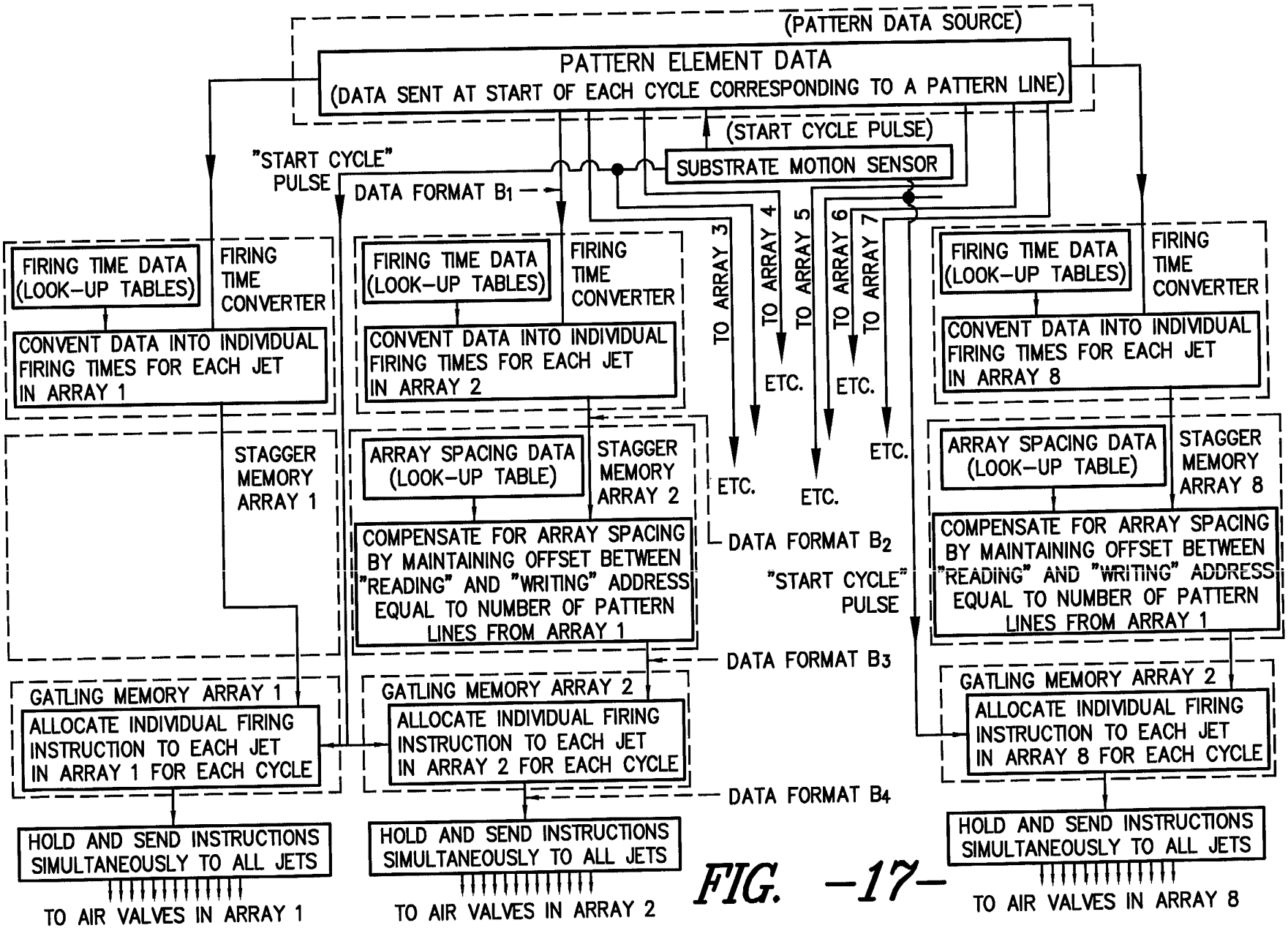

(PATTERN DATA SOURCE)
PATTERN ELEMENT DATA
(DATA SENT AT START OF EACH CYCLE CORRESPONDING TO A PATTERN LINE)
(START CYCLE PULSE)
SUBSTRATE MOTION SENSOR
"START CYCLE" PULSE
DATA FORMAT B1
TO ARRAY 3
TO ARRAY 4
TO ARRAY 5
TO ARRAY 6
TO ARRAY 7
ETC.
ETC.
ETC.
ETC.
ETC.
FIRING TIME DATA (LOOK-UP TABLES)
FIRING TIME CONVERTER
CONVENT DATA INTO INDIVIDUAL FIRING TIMES FOR EACH JET IN ARRAY 1
FIRING TIME DATA (LOOK-UP TABLES)
FIRING TIME CONVERTER
CONVENT DATA INTO INDIVIDUAL FIRING TIMES FOR EACH JET IN ARRAY 2
FIRING TIME DATA (LOOK-UP TABLES)
FIRING TIME CONVERTER
CONVENT DATA INTO INDIVIDUAL FIRING TIMES FOR EACH JET IN ARRAY 8
STAGGER MEMORY ARRAY 1
ARRAY SPACING DATA (LOOK-UP TABLE)
STAGGER MEMORY ARRAY 2
COMPENSATE FOR ARRAY SPACING BY MAINTAINING OFFSET BETWEEN "READING" AND "WRITING" ADDRESS EQUAL TO NUMBER OF PATTERN LINES FROM ARRAY 1
DATA FORMAT B2
"START CYCLE" PULSE
ARRAY SPACING DATA (LOOK-UP TABLE)
STAGGER MEMORY ARRAY 8
COMPENSATE FOR ARRAY SPACING BY MAINTAINING OFFSET BETWEEN "READING" AND "WRITING" ADDRESS EQUAL TO NUMBER OF PATTERN LINES FROM ARRAY 1
DATA FORMAT B3
GATLING MEMORY ARRAY 1
ALLOCATE INDIVIDUAL FIRING INSTRUCTION TO EACH JET IN ARRAY 1 FOR EACH CYCLE
GATLING MEMORY ARRAY 2
ALLOCATE INDIVIDUAL FIRING INSTRUCTION TO EACH JET IN ARRAY 2 FOR EACH CYCLE
GATLING MEMORY ARRAY 2
ALLOCATE INDIVIDUAL FIRING INSTRUCTION TO EACH JET IN ARRAY 8 FOR EACH CYCLE
DATA FORMAT B4
HOLD AND SEND INSTRUCTIONS SIMULTANEOUSLY TO ALL JETS
HOLD AND SEND INSTRUCTIONS SIMULTANEOUSLY TO ALL JETS
HOLD AND SEND INSTRUCTIONS SIMULTANEOUSLY TO ALL JETS
TO AIR VALVES IN ARRAY 1
TO AIR VALVES IN ARRAY 2
TO AIR VALVES IN ARRAY 8

FIG. -17-

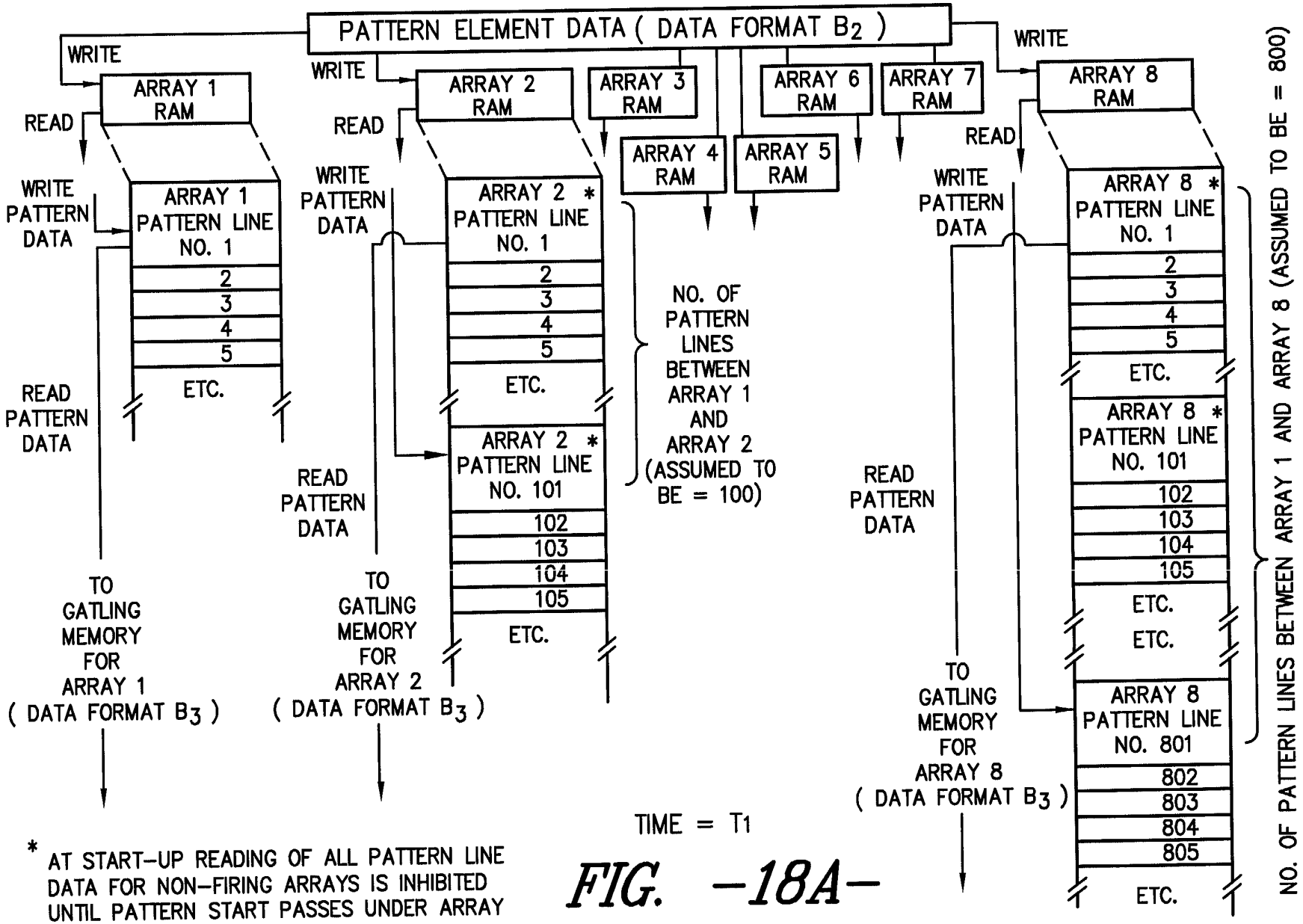

PATTERN ELEMENT DATA (DATA FORMAT B2)
WRITE
READ
ARRAY 1 RAM
ARRAY 2 RAM
ARRAY 3 RAM
ARRAY 4 RAM
ARRAY 5 RAM
ARRAY 6 RAM
ARRAY 7 RAM
ARRAY 8 RAM
WRITE PATTERN DATA
READ PATTERN DATA
ARRAY 1 PATTERN LINE NO. 1
ARRAY 2 * PATTERN LINE NO. 1
ARRAY 2 * PATTERN LINE NO. 101
ARRAY 8 * PATTERN LINE NO. 1
ARRAY 8 * PATTERN LINE NO. 101
ARRAY 8 PATTERN LINE NO. 801
2
3
4
5
102
103
104
105
802
803
804
805
ETC.
NO. OF PATTERN LINES BETWEEN ARRAY 1 AND ARRAY 2 (ASSUMED TO BE = 100)
NO. OF PATTERN LINES BETWEEN ARRAY 1 AND ARRAY 8 (ASSUMED TO BE = 800)
TO GATLING MEMORY FOR ARRAY 1 (DATA FORMAT B3)
TO GATLING MEMORY FOR ARRAY 2 (DATA FORMAT B3)
TO GATLING MEMORY FOR ARRAY 8 (DATA FORMAT B3)
TIME = T1
* AT START-UP READING OF ALL PATTERN LINE DATA FOR NON-FIRING ARRAYS IS INHIBITED UNTIL PATTERN START PASSES UNDER ARRAY

FIG. -18A-

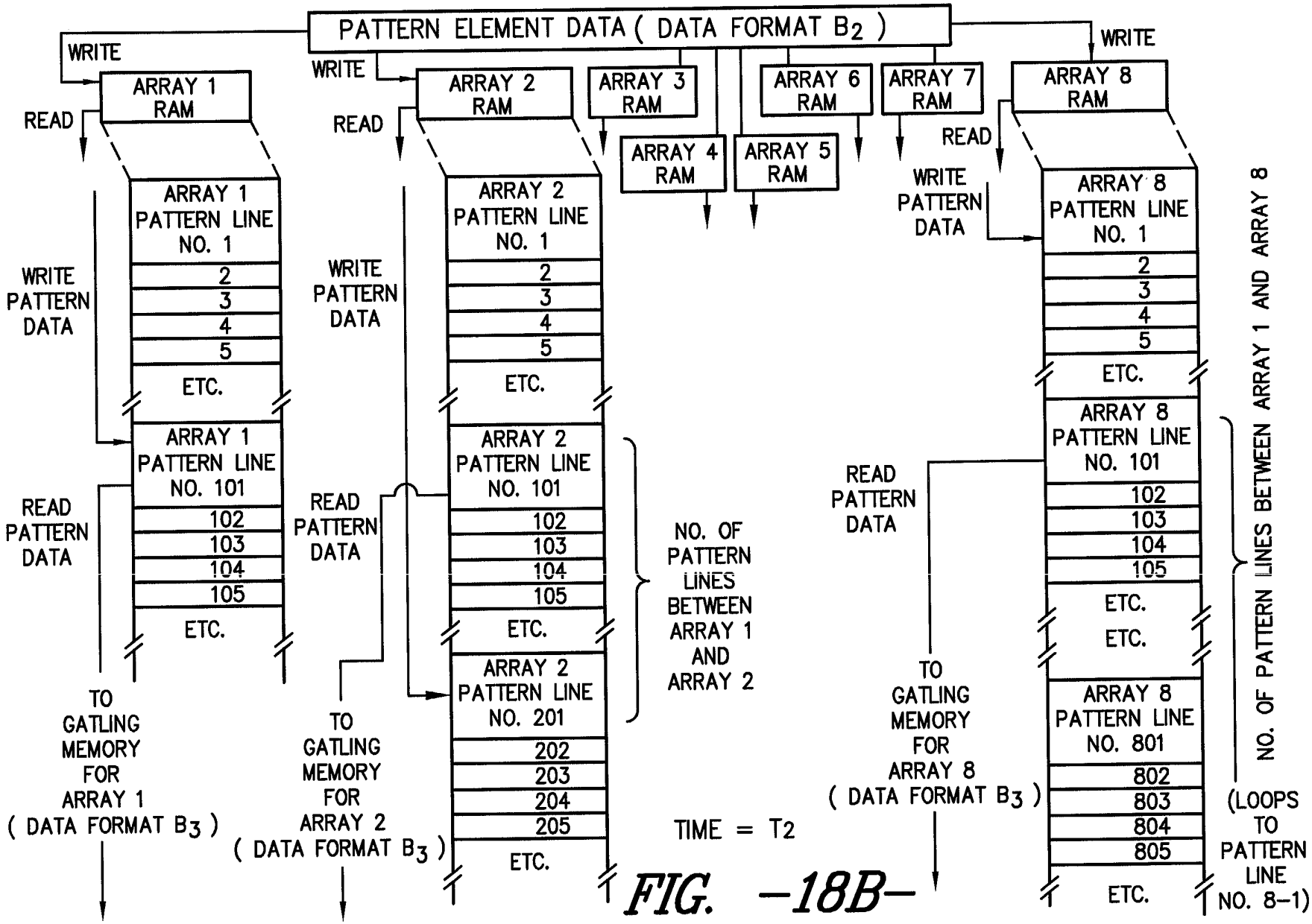


FIG. -18B-

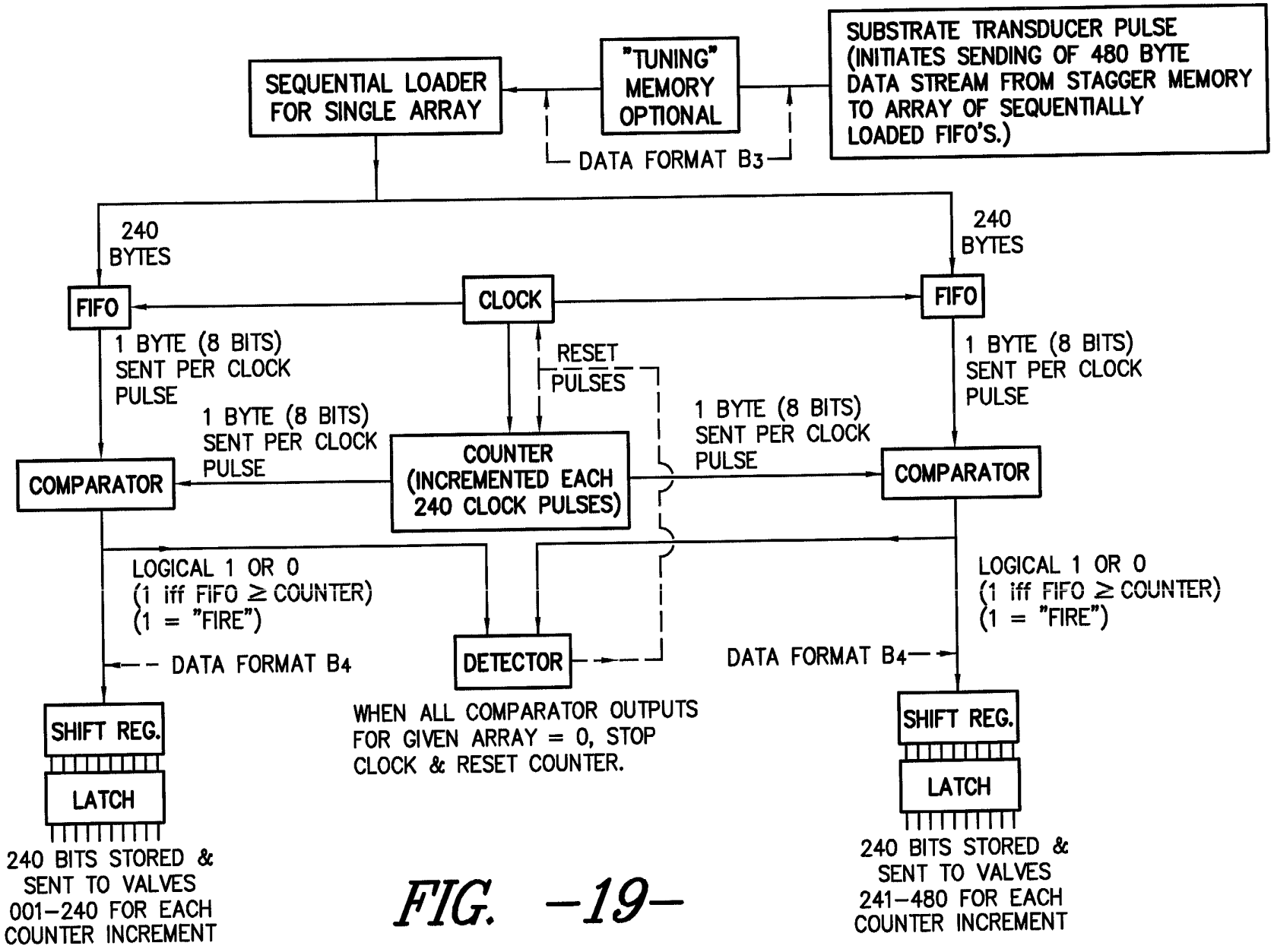
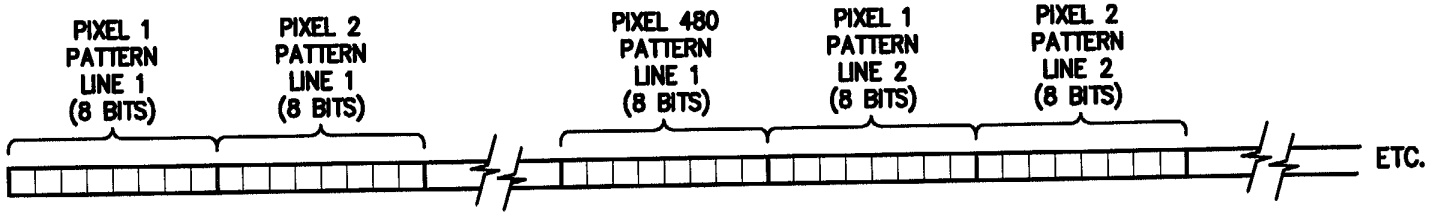
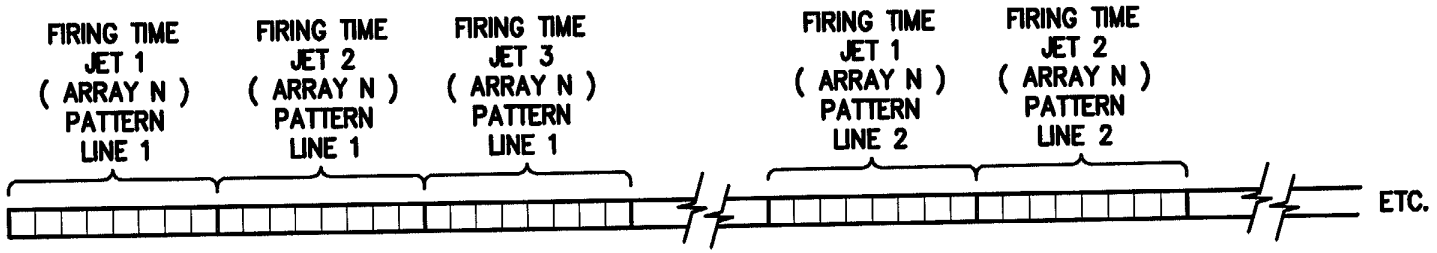


FIG. –19–

DATA FORMAT B_1 :
(OUTPUT FROM PATTERN DATA SOURCE)
8 BIT GROUP
DEFINES 1 OF 256
PRE-DEFINED
PATTERN ELEMENTS



DATA FORMAT B_2 :
(OUTPUT FROM PATTERN DATA SOURCE)
EACH 8 BIT GROUP
DEFINES 1 OF 256
POSSIBLE FIRING TIMES



DATA FORMAT B_3 :
(OUTPUT FROM STAGGER MEMORY)
DATA HAS BEEN RESEQUENCED/DELAYED
TO ACCOMODATE INTER-ARRAY SPACING

DATA FORMAT SAME AS B_2

DATA FORMAT B_4 :
(OUTPUT FROM PATTERN DATA SOURCE)
EACH BIT INDICATES
"FIRE / NO FIRE"
COMMAND FOR
GIVEN ARRAY

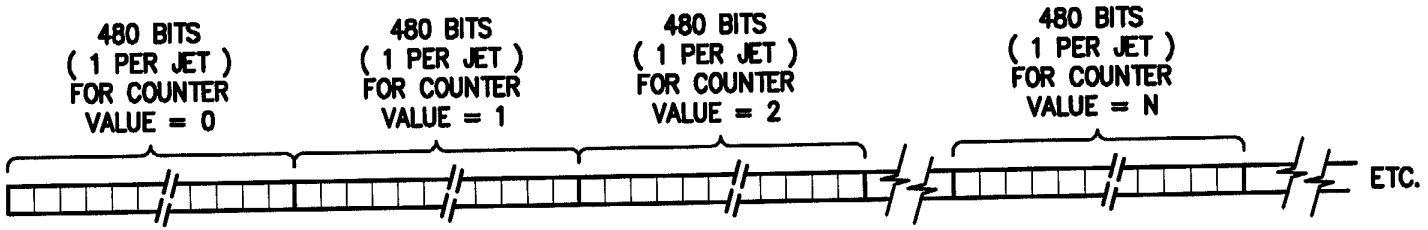


FIG. -20-

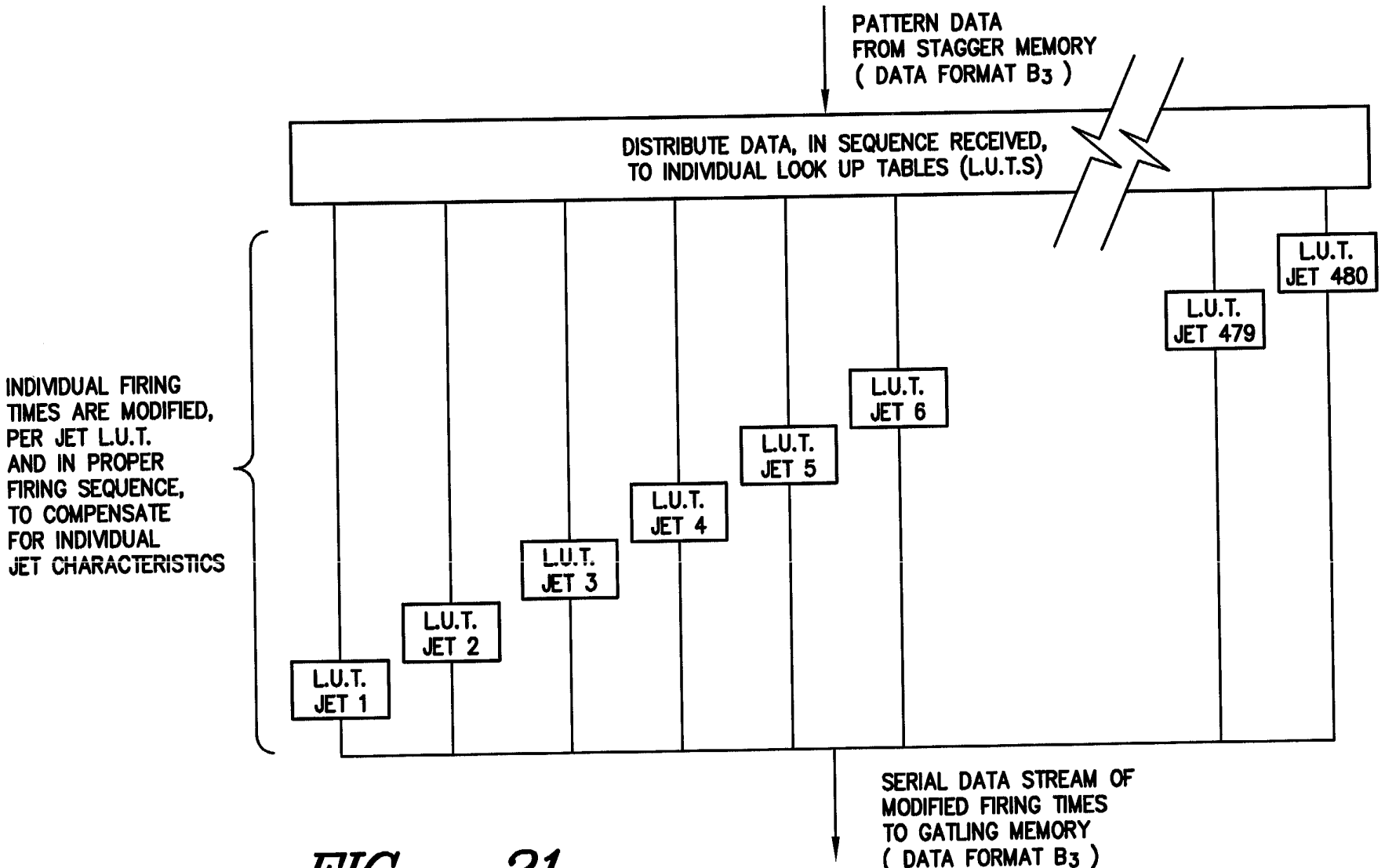


FIG. -21-